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Farman Goliath Transport Airplane

VOLUME VII
Number 11

Three Dollars a Year

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THE CHICAGO AERONAUTICAL SHOW
NEW GLENN L. MARTIN AIRPLANES
THE FARMAN GOLIATH TRANSPORT AIRPLANE
AIRPLANE WING COVERINGS
THE FIAT 600 HP. AIRCRAFT ENGINE

PUBLISHED SEMI-MONTHLY
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COLLEGE POINT NEW YORK

JANUARY 1, 1920

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Vol. VII January 1, 1920 No. 11

THE annual report of the Secretary of the Navy contains, as may be expected, numerous references to the importance of aircraft in naval warfare. Some of these are highly significant insofar as they imply that our naval authorities are fully alive to the great changes the employment of aircraft will bring about not only in naval tactics and strategy, but also in the design and construction of warships.

The following quotation from the report is in particular worth reproducing:

"The development and use of aircraft in naval warfare during the recent Great War has shown to us the great possibilities of this branch of the service in the near future. The development of aircraft for use in scouting, spotting and actual attack against vessels, with guns, torpedoes and bombs, will be so great that it is impossible to foresee or predict today what the result will be a few years hence. Since it is impossible to foresee the results of development, it will be necessary for the United States Navy to encourage and support adequate development of aircraft for naval purposes."

These views assume special significance in connection with some recent utterances by two well known British naval experts, Lord Fisher and Sir Percy Scott.

Lord Fisher says in his "Memories" that "it is clear as daylight that future war at sea precludes the use of any vessel that cannot go under water, because aircraft will compel it," and further, "unless warships can get under water, they will be blown out of the water." He adds that "all you want is the present naval side of the Air Force—that is the future navy."

This view is fully shared by Sir Percy Scott, the great gunnery expert of British Navy. Though the implication to scrap at once all surface ships may seem somewhat premature, it cannot be gainsaid that the time is not far off when surface fighting ships will become obsolete and naval warfare will mainly be conducted by undersea boats and aircraft. Hence it is of the utmost importance that the Navy, our first line of defense, keep abreast with, and, if possible, ahead of, the development of naval aircraft in other countries.

The naval air appropriation recommended by the Secretary of the Navy seems sufficiently substantial to allow for adequate development of naval aircraft during the coming fiscal year, but it represents the necessary minimum and should not, therefore, be reduced by Congress.

The report also contains some of Secretary Daniels' views regarding a separate air service, with which, as is well known, he is out of all sympathy. In the present report he again lays emphasis upon what seems to him "the necessity of developing aviation as an integral part of our military and naval forces," and he admits furthermore that "we are making naval aviation more and more an integral part of the fleet, to accompany our fighting ships and operate with them wherever they may sail."

While the second part of the last sentence is a thoroughly sound policy, one cannot agree with Secretary Daniels' views as to making naval aviation a "more and more" integral part of the Navy. Indeed, this means in so many words that naval aviation is being—and has already, in fact—been shorn of the little autonomy it possessed, so that if a separate air service is created, the naval branch will be so intertwined among the various bureaus of the Navy that the process of untangling it will appear a hopeless performance.

In these days, when aviators are given special training for bombardment aviation, pursuit aviation, and observation aviation, to name only the principal branches of the overland air service, it is difficult to understand why aviators of a single air force could not likewise be specially trained in the art of naval scouting, gun spotting, submarine hunting, etc. That naval scouting, for instance, requires aviators capable of distinguishing a battleship from a battle cruiser, or a scout from a flotilla leader, or an emerged submarine from an oil tanker, and this at distances at which only the deckworks of the ship in question may be over the horizon, does not disprove our contention in the least. The fulfillment of such requirements is merely a matter of efficient training and nothing else.

The main trouble with those opposed to a single air service is that they cannot—for traditional reasons—conceive the warfare of the future as it will be, that is, *from the air down*, but still imagine it as it was in the days of Hannibal and Napoleon, and look upon aircraft *from the ground or the sea up*.

Pontoon Forms

It is a curious feature of pontoon design that no very definite principles are yet established regarding their form. Their plan may be rectangular, or not, the top arched or flat, the bottom V shaped or flat. There may be a step or none. The pontoon may approach a stream line form or be ridiculously inefficient as far as aerodynamic resistance is involved. Basin tests are contradictory and never very conclusive. No definite theories have been evolved. The whole subject is on a most empirical basis. Yet seaplanes seem to get off and land

The Chicago Aeronautical Show

Aeromarine Model T-50 Flying Boat
(c) *Central News Photo Service*

The Chicago Aeronautical Show, organized by the Manufacturers Aircraft Association and the first of its kind ever held in the West, will open in the Coliseum on Jan 8 and will run continuously until Jan. 15

Most of the American aircraft manufacturers are exhibiting their latest products in this show and interesting displays will be made by the Army, the Navy and the Aerial Mail Service. The latter has scheduled the start of the Chicago-Omaha aerial mail route for the opening day of the show, an event which will emphasize the policy of aerial mail extension fostered by the Post Office Department.

The War Department has loaned the Aeronautical Show E Rickenbacker's famous Nieuport pursuit biplane, which America's leading ace used in achieving his record of twenty-four victories. This will be the first opportunity the public will have for examining this interesting machine, immediately after the show the ship will be placed on permanent exhibition in the Smithsonian Institute, Washington, D. C.

Another exhibit of historical interest will be one of the early machines on which the late Lincoln Beachey gave numerous exhibitions of acrobatic flying

Some of the principal exhibits are described herewith in anticipation of a technical review of the Show which will appear in the following issue of Aviation and Aeronautical Engineering

Aeromarine

The Aeromarine Plane and Motor Co. exhibits a Flying Yacht, which is their Model T-40 whose luxurious appointments make the new name very appropriate In addition to the general soundness and efficiency of design that invariably distinguishes the Aeromarine models some new and interesting features have been employed to meet the desirable conditions of touring and sporting.

The Yacht is fitted with a full side yacht entrance to the comfortable enclosed cabin, which accommodates three persons, while the door of the cabin opens to the front, permitting easy access The hull and exposed wood work are finished in mahogany, while a liberal amount of upholstery, of best quality buff leather, is used throughout the cabin All the instruments requisite for flying are fitted in the cabin together with numerous appointments such as cigar lighters, etc , that are found in the saloon of the most luxurious yachts and in the limousine type motor cars

Pictures of the new Flying Yacht are not available as we go to press, but the main dimensions, structural characteristics and performance figures are indicated by the following outline.

Type—Flying Boat Pusher Biplane.

Power Plant—Aeromarine B-150 hp eight cylinder type or L-130 hp direct six cylinder vertical unit with starter and generator.

Main Dimensions

Spread—Upper wing	48 ft 4 in.
Spread—Lower wing	37 ft. 4 in.
Stagger	8 in.
Chord	78 in
Gap	78 in
Dihedral	2 deg.
Area—Upper panel (with ailerons)	300 sq ft
Area—Lower panel	200 sq ft
Ailerons—Each	20 sq ft.
Elevator—Each	12 8 sq ft.
Stabilizer fin	39.5 sq ft.
Vertical stabilizer fin	18 sq ft.
Rudder	17 5 sq ft
Skid fin	6.5 sq ft
Length over all	28 ft. 11 in
Weight, light	1825 lb.
Weight, loaded	2485 lb
Gasoline	65 gal

Performance with L-130 Engine

High speed	80 m.p.h
Low speed	38 m p.h
Climb 2500 ft in 10 min	

Curtiss

Four distinct and thoroughly up-to-date types of peace-time airplanes commercial and pleasure flying craft—together with the greatest fighting plane in the world, will be shown by the Curtiss Aeroplane and Motor Corp Included in the exhibit will be the company's latest achievements in aeronautical motors and also a miniature model of the Curtiss wind tunnel and models of the machines which have been produced by the company during the past year, among them the now famous NC (Navy Curtiss) 4, which was the first airplane to cross the Atlantic Ocean.

Interest will undoubtedly be centered in the Curtiss Eagle, eight-seater airplane—the modern aerial Pullman—and in the Curtiss Wasp, which now holds the world's altitude record of 34,910 feet, in addition to the world's records for climb and speed The other airplanes in the exhibit include the Curtiss Oriole, three-seater land plane; the Curtiss Seagull, three-seater flying boat; the Curtiss JN-4D, the standard training plane, the Curtiss six and twelve cylinder motors, and the Curtiss OX-5, probably the best known and widest used motor in the world.

These products are for the most part the result of the year's activity on the part of the Curtiss Aeroplane and Motor Corp which, like all other American aeronautical manufacturers, at the beginning of the year found itself confronted with the problem of changing from an enormous war-time production basis, which extended over a three-year period during which the company was engaged in building airplanes and flying boats for the U. S Army and Navy as well as for the allied governments, to a peace-time basis

While the process of production-transformation was going on, the Curtiss company determined to pioneer the way for commercial aviation.

In order to accomplish this, W W Mountain, Vice-President and General Manager of the company, perfected a commercial sales organization with J P Davies, formerly of the U S Air Service, as Sales Manager. Following methods used by automobile manufacturers, an organization of distributing companies with dealers' sub-agencies was built up. As a result of this plan, the United States is now covered with a net-work of distributing agencies handling Curtiss products. At the same time, agencies have been established in many foreign countries. Simultaneously, Curtiss designers and engineers began work on peace time planes—this work culminating in the design and construction of the Curtiss Eagle

Because it meets the popular demand for an airplane of medium size to be used to transport either passengers or freight at low operating cost, the Curtiss Eagle has been hailed by aviation authorities as the type of plane that will popularize aerial transportation Its multi-motor equipment—Three Curtiss Six, 150 hp motors—provide insurance against the dangers of forced landings and, at the same time, give speed, endurance and economy of operation. Its cabin, fully enclosed, provides comfortable accommodation for its passengers who, while protected from the wind and cold and, to some extent, from noise, are enabled to travel with much the same ease as in a parlor car or limousine, viewing the landscape through non-breakable glass windows. The cabin, provided with wicker chairs, with plenty of aisle, space, is entered from a side door The motors are equipped with self-starters.

The Eagle has a maximum speed of 105 m.p h and lands at approximately 50 m.p.h. It has a flying radius of 350 mi at full power or 475 mi. with the motors throttled. It has a wing-span of 61 ft 4 in. Its length is 36 ft 9 in and its height is 12 ft 4 in Its gross weight is 7,450 lb. and its useful load 2,320 lb.

The Curtiss Wasp is a fighting plane, designed to meet the requirements for a pursuit plane at a time when the American Air Service was without a machine capable of competing successfully against those of the Hun Although the Wasp did not reach the fighting lines, subsequent performances, together with the testimony of pilots who have flown it, have stamped it as one of the most formidable fighting planes in the aeronautical world Equipped with special altitude wings and with the Curtiss K-12, 400 hp motor, the Wasp, in September, 1919, piloted by Roland Rohlfs, Curtiss test pilot, ascended 34,910 ft., establishing a new world's altitude record and, on the following day, made a new world's record for climb—20,000 ft. in ten minutes. With military load, consisting of machine guns and ammunition, the Wasp made a record of 162 m.p.h in government speed tests. Several of these machines have been built and sold to the U S Navy and the Bolivian government has added the Wasp to its aviation equipment.

The standard Wasp model has a wing span of 31 ft. 11 in and a wing surface of 300 sq ft. It is 23 ft 3 in long and 9 ft. 10½ in. in height The machine weighs, fully loaded,

Curtiss Oriole Passenger Airplane

Curtiss Seagull Passenger Carrier Seaplane

2,900 lb and carries a useful load of 1,000 lb. Its maximum range at economic speed is about 550 mi.

The Curtiss Oriole, first three-seater land plane built in America, was designed to meet the demand for a plane with the dependability and stability of the well-known Curtiss JN yet adapted more to the peace-time requirements of space for an extra passenger, greater speed, additional fuel capacity for cross country work and greater attention to the niceties which make for comfort. The front cockpit is wide, the passengers having plenty of room seated side by side, in deep leather-upholstered seats, protected by a curved windshield. A cut-in side door is a modern, up-to-date convenience, while a self starter does away with the necessities of hand-cranking.

The Oriole is 25 ft. long and 9 ft. 6 in. in height. It has a wing span of 36 ft. It is equipped with the Curtiss Six, 150 hp motor which gives it a speed of 96 m.p.h. It lands at 50 m.p.h. Its flying radius is 290 mi. at high speed or 440 mi. with the motor throttled. Its weight, with a useful load of 790 lb., is 2,354 lb.

The Oriole has contributed much to aviation history during its first year. One of these machines was flown from Buffalo to Houston, Texas, and back to New York, carrying three passengers. The round trip, covering 5,000 mi., was made in less than 40 hr., actual flying time. The Oriole has blazed the trail as an aerial carrier in the oil fields of Texas and Oklahoma, many being used by oil operators. It also made the record breaking flight between Buffalo and New York—440 miles in four hours and five minutes.

The Curtiss Seagull, designed for the same purposes as the Oriole, is a three-passenger flying boat which is ideally adapted to pleasure flying, making possible aerial pleasure cruises of from three to four hours' duration without refuelling. The passenger compartment is wide and roomy. The seats leather-upholstered. The windshield affords protection from wind and spray, and at the same time, does not detract from the wonderful vision which is obtainable from the sky. The Seagull's utility is not confined to pleasure flying; it is admirably suited for carrying passenger and package.

It belongs to the small flying boat class, being 28 ft. 10⁷⁄₈ in. long and 11 ft. 6 3/32 in. in height. It has a wing span of 49 ft. 9⅝ in. The total weight with a full load is 2,726 lb. and it carries a useful load of 769 lb.

The Seagull is equipped with the Curtiss Six, 150 hp. motor and has a maximum speed of 76.5 m.p.h. and a minimum speed of 48.5 m.p.h. Its endurance is 288 mi. or 4.8 hr. at economical speed. A self-starter is one of the modern conveniences in the Seagull's standard equipment.

Its performances, during the first year of production, have added a remarkable chapter to 1919 aviation history. The first Seagull, shipped to the Scandinavian countries, has been successfully flown more than 5,000 mi. under all conditions. It has made two record-breaking flights—one a cross-country journey from Christiania, Norway, to Stockholm, Sweden, and another a thousand mile trip between Christiania and Helsingfors, Finland, touching at Skagen, Denmark, Copenhagen and Stockholm. Seagulls were used in inaugurating a regularly scheduled transportation line between San Pedro and the Catalina Islands. Another Seagull is now on a 5,000 mile trip from New York to New Orleans, following the Hudson, St. Lawrence, Ohio and Mississippi waterways.

Dayton-Wright

The Dayton Wright Airplane Co. of Dayton, Ohio, will contribute to the Aeronautical Show in Chicago two new and interesting types of airplanes designed and constructed to meet the requirements of commercial and tourist flying, namely, Model O. W. 1 Aerial Sedan and Model K. T. Cabin Cruiser.

Dayton-Wright Aerial Coupe, Model OW-1

The three-passenger Aerial Sedan Model (shown above), equipped with the Hispano-Suiza Type E motor provides the buyers of sporting and touring aircraft with a machine that combines all the comforts and luxuries of the limousine type motor car with the efficiency and delight found in flying through the air.

No pains have been spared in the refinement of structural details, etc., to give the sportsman and tourist a plane that meets his every requirement while the main structural characteristics have been carried through in most interesting and noteworthy fashion to avoid the undesirable features of flying, such as cramped seating arrangements, protection from the wind, noise of the motor, provisions for luggage, etc. Complete visibility when seated in the cabin is accomplished in a very interesting manner.

Provision is made for carrying sufficient fuel for approximately 5½ hr. continual flying which is very desirable for cross country flights.

The Hispano Suiza motor, several of which are exhibited by its makers, the Wright Aeronautical Corp., needs no introduction or discussion as to its desirability. Its 180 hp. gives the ship a maximum flying speed of ninety-five m.p.h. with a landing speed of 35 m.p.h., a speed range which is very satisfactory for a machine of this type.

For night flying, Holt Flare lights are provided, supplying ample illumination for landing.

The K. T. Model Cabin Cruiser (shown on p. 473), a commercial and load-carrying machine, is powered with the Liberty Twelve motor, giving a high speed performance with a large load-carrying capacity.

Either freight or passengers may be carried,—when the former is desired, the seats can be readily removed to leave

the roomy cabin free for loading. A six-hour cruising radius is provided in view of the long distance work at high speed that is attendant upon a commercial plane,—while a high factor of safety over all is guaranteed by the company.

The manner in which the Liberty is cowled in should be noted and the method by which the exhaust gases are carried up over the center section should not be overlooked. The cutting down of fire hazard which is gained thereby is a most desirable improvement in addition to the satisfaction gained by reducing the effect on the passengers of the motor noises and exhaust fumes.

Complete specifications of both machines are given by the Dayton Wright Co. as follows:

Aerial Coupe, OW 1

General Dimensions—	
Wing span—upper wings	48 ft.
Wing span—lower wings	46 ft.
Depth of wing cord	6 ft. 6 in.
Gap between wings	5 ft. 6⅝ in.
Stagger	None
Angle of incidence	3 deg.
Dihedral	None
Sweepback	None
Wing curve	Modified R. A. F. 15
Horizontal adjustable stabilizer	(2 deg. positive)
Setting to line of flight	(3 deg. 30 min. negative)
Overall length	28 ft. 8 in.
Overall height	9 ft.
Areas—	
Wings—upper including ailerons	267.00 sq. ft.
Wings—lower, including ailerons	267.00 sq. ft.
Ailerons	62.00 sq. ft.
Horizontal stabilizer	30.00 sq. ft.
Elevators	22.8 sq. ft.
Rudder (balanced)	10.63 sq. ft.
Total supporting surface	534.00 sq. ft.
Weights and Loading—	
Net weight empty	1480 lb.
Gross weight loaded	2482 lb.
Wing loading	4.66 lb. sq. ft.
Power loading	13.83 lb. hp.
Factor of safety	6.8
Power Plant—	
Hispano-Suiza, Model E, 180 hp. at 1450 r.p.m.	8 cylinder, 4 cycle
Fuel tank capacity	70 gal.
Fuel consumption per hr. (economical)	13 gal. per hr.
Oil capacity—tank and crankcase	5 gal.
Oil consumption per hr. (economical)	0.3 gal. per hr.
Nose radiator (Honeycomb Harrison type)	
Performance—	
Speed maximum horizontal flight	95 m.p.h. (estimated)
Speed minimum horizontal flight	35 m.p.h. (estimated)
Radius of action (economical fuel)	5.4 hr. (estimated)
Radius of action (economical oil)	10.0 hr. (estimated)

Cabin Cruiser KT 1

General Dimensions—	
Wing span—upper plane	43 ft. 7½ in.
Wing span—lower plane	43 ft. 7½ in.
Depth of wing chord	5 ft. 6 in.
Gap between wings	5 ft. 10 in.
Stagger	11⅝ in.
Length of machine overall	30 ft. 1 9/16 in.
Height of machine overall	11 ft. 2½ in.
Angle of incidence	3 deg.
Dihedral angle	0 deg.
Sweepback	0 deg.
Wing curve	R. A. F. 15
Horizontal stabilizer angle of incidence	1 deg. 0 + 7½ deg.
Areas—	
Wings—upper including ailerons	212.36 sq. ft.
Wings—lower, including ailerons	214.36 sq. ft.
Center section	14.37 sq. ft.
Ailerons	71.8 sq. ft.
Horizontal stabilizer	38.42 sq. ft.
Vertical stabilizer (fin)	6.00 sq. ft.
Elevators (each 12 sq. ft.)	24.00 sq. ft.
Rudder	13.48 sq. ft.
Total supporting surface	441.08 sq. ft.
Wing loading (weight carried per sq. ft. of supporting surface)	9.3 lb. sq. ft.
Power loading	9.82 lb. hp.
Factor of safety	6
Weights—	
Net weight, machine empty	2986 lb.
Gross weight (machine, oil, gas, water 2 passengers & pilot)	4128 lb.
Performance—	
Speed—maximum horizontal flight	120 m.p.h.
Speed—minimum horizontal flight	55 m.p.h.
Climbing speed	10,000 ft. in 10 min.
Radius of action (economical)	6 hr.
Motor—	
Model—Liberty 12 420 hp. at 1700 r.p.m.	
Fuel consumption per hour (economical)	21 gal.
Fuel tank capacity	128 gal.
Oil capacity provided	13½ gal.

Edstrom

The first Edstrom wire wrapping machine was built in the Fowler Aeroplane Factory in San Francisco, during the spring of 1918. This machine turned out cables for fifteen planes for the Fowler Co. and, immediately after, seventy-five planes for Howell and Lesser Aeroplane Co., also of San Francisco,—equipping thus ninety planes all told, without one cable rejection.

In August and September, 1918, a larger and much improved machine was built in Chicago, and was demonstrated at McCook Field, Dayton, Ohio, from Nov. 16 to 20, 1918, where the tests on sixty cables were conducted. Ten of these, tested without soldering, gave the following results: "Of the ten unsoldered specimens, sizes ⅛ to 5 3/32 in., only one failed at a load below the rated capacity of the cable. The ⁵⁄₈ in. specimen served with copper wire failed at loads averaging 71 per cent of the full strength of the cable." It should be noted that the nine specimens that stood the one hundred per cent of rated tensile strength of the cable were wrapped

Dayton-Wright Cabin Cruiser, Model KT-1

by a special hard, strong, wrapping wire which is being used by the machine,—a wire that cannot be used by hand as it is too stiff and springy.

In April, 1919, the machine was demonstrated at the Aeronautical Show held in the Madison Square Garden in New York, where it created a great deal of favorable comment from persons interested in wire and cable work for airplanes.

Since the New York Show, Mr. Edstrom has added four more machines to the first two, the later wrapping machine having a bending machine run in connection with it. The new machine consists of a tying machine, a cutting machine, a machine for binding the fuselage or hard wire and doing away with the female, soldering and a test machine.

This complete unit of wire and cable sewing machine is now in operation in the Edstrom factory headquarters at Seventh and Webster Avenues, Long Island City, New York, where they are doing contract work, turning out the cables for so much per wrap. The first work turned out after the machine was installed was to replace an entire set of cables on a plane for the Lewis and Vought Aeroplane Co.

Interallied Aircraft

The Interallied Aircraft Corp., of New York, will exhibit at Chicago representative types of their British-built Avro airplanes.

To those familiar with the most successful types of British machines little need be said of the qualities of the Avro models, since it has been generally conceded by British aeronautical authorities that for the purposes for which they were built, the Avros proved most satisfactory. They are extremely comfortable machines to fly and permit of all kinds of stunting.

Two Avro models will be shown at the Chicago show, one an open body machine, which is the well known training plane Model 504 K, and a three-place limousine plane, called Model 504 M, which differs from the former mainly by virtue of its enclosed body. This model is specially designed for pleasure flying and touring.

Both models are fitted with 110 hp. Le Rhone rotary engines, which furnish a high speed of 90 m.p.h. at ground level, and 75 m.p.h. at 10,000 ft. The landing speed is 35 m.p.h.

The span, top and bottom, is 36 ft., the overall length 28 ft. 11 in., and the wing area 330 sq. ft. The machine weighs empty 1,230 lb., and loaded 1,823 lb.

B-G Spark Plugs

The B-G spark plugs, which have well demonstrated their great reliability in various cross country flights, and particularly in the Transcontinental Reliability Race and in the Round-the-Rim flight, will also have a stand at the Chicago Aeronautical Show.

Extract from Fifth Annual Report of the N. A. C. A.

The science and art of aeronautics made wonderful progress during the war, due to the stimulus of necessity. Over 11,000 aviators were trained in this country, with a loss of 264 lives in training, and more than 13,000 airplanes were constructed in the United States. There were great delays, however, in getting an effective air force into action during the war, due primarily to the general lack of preparation for war, but particularly due to the lack of a proper scientific and technical foundation before the war.

From the lessons of the war, we know that aeronautics will be the first arm of defense and of offense to come into action in future wars. Victory will sharply incline to the side that establishes superiority in the air, though its other forces may be relatively weaker than the enemy's.

Several European nations are making strenuous efforts and comparatively huge peace time expenditures to develop aeronautics and to maintain a trained reserve personnel. In America we have a force of reserve military aviators, but our peace-time expenditures for the maintenance of an aircraft industry and the further development of aeronautics are small. The committee invites the attention of the Congress to the need for providing encouragement for the development of commercial aviation, as well as military aviation, and to the need for more liberal support of scientific research and experimental work in aeronautics. There are many practical problems involved in the development of aeronautics commercially, and the commercial development, aside from being its own reward, will be a distinct military asset in time of war, and should therefore be encouraged and guided as far as practicable by the Government. In this connection the remarkable record of the Air Mail Service is encouraging. In the first place the Post Office Department sought and obtained the advice of the National Advisory Committee for Aeronautics, and through it obtained material assistance from other agencies of the Government, particularly the Signal Corps of the Army. Its continued independent development should be encouraged.

To summarize the more immediate and important matters, the committee strongly recommends to the Congress:

First, That liberal support be given to the estimates and programs for the development of military, naval and postal air services.

Second, That greater support be given to the National Advisory Committee for Aeronautics in its program for the continuous scientific study of the problems of flight. This is particularly desirable because of the great increase in the number and importance of the problems to be solved and the reduced volume of experimental work conducted by other agencies since the signing of the armistice. Greater direct support of scientific research and experimental work in aeronautics becomes a necessity in view of the limited appropriations for the Army and Navy Air Services, and the consequently limited encouragement and limited ability of the aircraft industry to conduct experimental and development work.

Third, That special steps be taken at once through the proper governmental channels to encourage foreign trade in aircraft. The committee suggests that it may be advisable to send a special aeronautical mission to South American countries to create markets for American aircraft and to interest and advise the commercial attaches of the Department of Commerce and the consular agents of the State Department as to the possibilities of aeronautics in those countries and the ability of the American aircraft manufacturers to meet the needs.

Fourth, That every practicable encouragement be given by the Federal Government to the establishment of landing fields in and by municipalities generally, and as near the centers of activity as possible. The committee especially suggests that the War Department be authorized to cooperate with the various municipalities at least to the extent of aiding in the lay-out and marking of the fields and the placing of at least one hangar on each field.

Fifth, That legislation be enacted for the regulation of civil aerial navigation, of the issuance of licenses to pilots, of inspection of aircraft, of uses of landing fields, etc., that the enforcement of regulations be placed under the Department of Commerce, and that, pending enactment of definite regulations by Congress, a board of representatives of various Government departments and of this committee be authorized to prepare such regulations for the approval of the Secretary of Commerce. The committee believes that air navigation should be regulated in much the same manner as marine navigation, and recommends the above as purely temporary legislation.

Sixth, That a continuing program for the construction of aircraft for the various governmental services be authorized, so as to assure, through the apportionment of relatively small orders among manufacturers of aircraft, the existence of a nucleus of an aircraft industry capable of expansion to meet military needs in an emergency.

Orenco Airplanes

The Ordnance Engineering Corp., of New York, builders of successful military airplanes for more than three years, has adopted the name Orenco to designate the products of its aircraft department. The achievements of the Orenco airplanes have often been brought to public attention, but as they were invariably referred to as "Ordnance airplanes" the impression was created in many minds that the machines were the product of the Ordnance Department of the United States Army. To correct this impression, all planes designed and built by the aircraft department of the Ordnance Engineering Corp. will henceforth be known as Orenco airplanes.

New Glenn L. Martin Airplanes

Three-Quarter Rear View of the Martin Mail Plane, Fitted With Two Liberty Twelve Engines

Six airplanes built for the Post Office Department by the Glenn L. Martin Company of Cleveland have been completed and delivered to the government and are now awaiting the erection of suitable hangars to go into regularly scheduled service. These big ships were the first twin-motored mail planes to be completed and pass their tests and are unique in construction, being the first airplanes in the world to be designed and built specially for the mail service.

The planes are similar in general specifications to the well-known Martin Bomber. They are 71 ft. 5 in. from tip to tip, 46 ft. from nose to tail and 14 ft. high. For power plant they have two 400-hp., high-compression Liberty motors, one mounted on each wing and turning tractor air screws. The performance tests in the specifications called for a speed of 108 m.p.h. with 270 gal. of fuel, pilot and mechanic and 1500 lb. of mail. Finding it possible to do so, the Martin company gave more room to the gas tanks, and at the time the plane underwent its tests it was filled up with 320 gal. of fuel, giving a range of 6 hr.

Three of the planes have been delivered to New York, while the remaining three have been kept in Cleveland pending the selection of new landing fields and the erection of suitable hangars. The three planes which were flown to New York were piloted by Walter H. Stevens of the Aerial Mail Service, with Eddie Waters as mechanician. All trips were successfully negotiated with loads of over 1000 lb. of mail. On the first trip Pilot Stevens was forced out of his course by a snowstorm and made a forced landing in Sullivan County, N. Y., but completed the 430-mi. journey in 4 hr. 50 min. The other two trips were non-stop affairs, in which the 430-mi. airline was negotiated in 3 hr. 31 min. and 3 hr. 50 min., respectively. On all three trips the plane showed a speed of considerably more than was called for in the specifications.

The six Martin mail planes are painted blue-black and their final coat of varnish gives them the appearance of a patent-leather finish. They are numbered from 201 to 206 inclusive, and the letters, in white with red shading, stand out boldly and are quite distinct at a height of 2000 ft.

One of the distinctive features of this plane is the bullet-shaped nose, which is quickly detachable. Only four bolts are used in fastening this solidly constructed member to the fuselage, so that in case of a forced landing, which would involve "nosing over," it will be a simple matter to fasten on a new nose in just a few minutes. Another serviceable feature is the

Three-Quarter Front View of the Martin Mail Plane. This Machine Has a Mail-Carrying Capacity of 1500 Lb.

arrangement of the fuselage covering in panels, which can be cut out in 20 min., completely exposing all the gasoline system and other parts on which the mechanics might wish to work.

The mail is carried in five roomy compartments, two of which are situated in the nose and the other three in the fuselage behind the crew. Four of these compartments are fitted with trap doors below, which can be operated from the pilot's cockpit. From these mail can be dropped with parachutes on the sacks while in flight, as was recently demonstrated in Washington, D. C., by pilot Stevens. They greatly facilitate the unloading of the ship on arrival at its destination. The fifth compartment, directly behind the pilot's compartment, has no trapdoor, and is used for carrying suit-cases or other impediments. The top of this compartment has been removed, and as many as four people have been carried in it. Commander Mixter and Lieut.-Commander Bellinger of the United States Navy recently took a trip in this compartment over Washington, D. C.

The present plans of the Post Office department call for the use of these ships on the New York-Cleveland-Chicago route, as their speed and fuel capacity makes them ideal for this work. As the aerial mail service is extended to Omaha, Minneapolis and St. Louis, it is quite probable that a large number of these planes will be purchased. They are adaptable for fast express service, as the mail compartments are extremely large, having a total capacity of over 100 cu. ft.

The Glenn L. Martin Co. is also well under way on an order for ten huge torpedo planes for the United States Navy. The first of these ships will be completed shortly after the first of the new year, and will then undergo its tests. The planes will be in many respects similar to the Martin Bomber as built for the United States Army, but will carry a 1500 lb. torpedo instead of 1500 lb. of bombs. General specifications are reminiscent of the bomber, one of the chief differences lying in the landing gear, which will be split to allow for the torpedo and its mechanism. The last eight of the order will be a trifle larger than the first two and will carry a 2100-lb. torpedo.

These planes are to be used for coast defense, and also in connection with the fleet, and will be fitted up with complete navigation instruments and with air bags for use in case of a landing in the ocean. Hooks in the upper wings allow the plane to be hauled up on board a war vessel. The securing of this order makes the Martin Co. by far the largest government airplane contractors since the signing of the armistice, their orders considerably exceeding the million-dollar mark.

Siemens-Schuckert Giant Biplane

Several 6-engined giants constructed at the Siemens-Schuckert Workshops have been adapted to commercial transport work.

Principal dimensions:

Span 48 m., length, 21.6 m., height, 7.20 m. Chord of upper wing, 5.20 m., of lower, 4.50 m. Lifting surface, 445 sq. m. Total weight of wing structure, 2,660 kilos.

There are 4 pairs of struts on each side of the centre. The wing ribs are of wood (pine or ash) and of girder form. The wing section is biconvex at the centre and of normal aerofoil type at the tips, the biconvex section being fitted only where the flow is rendered turbulent by the airscrews. The ribs of the ailerons are of steel.

The fuselage is built of steel tube, without lateral bracing. Whilst the rearmost portion has a covering of fabric, the middle and nose parts are covered with aluminum sheet. The tail resembles markedly that of the N C-4, which crossed the Atlantic.

The centre part of the fuselage communicates, by means of a metallic tower, with the upper plane, and the pilots have seats before the tower, at the top of the body, and above the motors. Everything necessary for motor repairs is carried in the interior of the fuselage.

The undercarriage consist of 8 wheels of 1.3 m. diameter, 4 on each side, bound to the fuselage by an assemblage of steel tubes with internal springs. Two wheels on a swivelling fork fulfil the function of tail skid.

There are six 300 hp. Maybach 6-cylinder motors, installed on two lines of three in the interior of the fuselage. A central passage gives access to all the motors in flight. The two foremost engines each operate a tractor airscrew of 4.5 m. diameter and 2.20 m. pitch, whilst the other four, coupled two by two, drive propelling screws of 5 m. diameter and 3.15 m. pitch. Total weight of machine, 10,000 kg. Useful load, 6,000 kg. It can carry 4,000 litres of petrol, representing 8½ hrs. flight, i.e., about 1,200 kilom. The wing rib structure is illustrated, but no other drawings are given. (L'Aérophile, July, 1919.)

THE "ALERION" HELICOPTER INVENTED BY L. LACOIN AND L. DAMBLANC, THE PATENTS FOR WHICH HAVE BEEN PURCHASED BY THE FRENCH GOVERNMENT

Photo Paul Thompson

The Farman Goliath Transport Airplane

The Farman Goliath transport airplane represents by virtue of its all-round performance a notable achievement in aeronautical engineering. This machine was originally designed as a long-range bomber, but as the armistice intervened before its construction was completed, the drawings were changed to allow for its use as a fast passenger carrier.

The first machine of this so-called F-60 type, the original Goliath, made its trials towards the end of 1918 and went into commission in February, 1919, on a weekly passenger service between Paris and Brussels. After several months of successful operation, which in particular proved that the machine could in case of emergency complete its journey by flying on one engine while carrying the allotted passenger load, the Goliath was refitted for a flight from Paris to Dakar, French West Africa, a distance of approximately 2500 sta. mi.

Before we enter into the technical aspects of this flight, attention is called to the accompanying outline drawings and illustrations. It may be seen from Fig. 2 that the Goliath is built along remarkably clean lines: the fuselage is well streamlined, and so is the engine installation, while the small number of interplane bays and the "trouser" arrangement of the undercarriage obviously reduce head resistance to a minimum. Another notable feature is the massing of the important weight items near the longitudinal axis of the machine, for this arrangement permits to fly on one engine with very little corrective setting of ailerons and rudder, and so limits the strain on the pilot as well as the deceleration caused by off-set control surfaces.

From the general outline drawings, Fig. 1, it will be seen that the Farman Goliath is a twin-tractor biplane with main planes of equal span and balanced control surfaces. The main planes have neither dihedral, stagger, or sweepback, and it is worth noting that the wing tips are, as are the ailerons, straight edged in plan view. This is highly commendable from the viewpoint of production, although curves may be conducive to greater beauty.

The general dimensions and the weight itemization of the machine, as normally equipped, appear in the outline drawings. That the disposable load should exceed the net weight of the airplane is a great tribute to the excellence of this design and constitutes a remarkable achievement, as hitherto only airships were credited with such a high efficiency ratio. That such a load-carrying capacity has not been attained at the cost of airworthiness is illustrated by the fact that the Goliath has, for a gross weight of 10,240 lb., a wing area of 1775 sq. ft., hence the wing loading is only 5.8 lb. per sq. ft. This, of course, explains the low-landing speed—from 30 to 35 m.p.h.—of the machine, a feature which always affords the best insurance for safe landing.

The high speed on both engines turning at 1700 r.p.m. is 190 m.p.h.; the cruising speed, at 1300 r.p.m., is 75 m.p.h. The normal cruising endurance with full load is 6 hr.

The climbing speed is as follows: 3000 ft. in 10 min. 30 sec., 4500 ft. in 17 min., 6000 ft. in 23 min., with full load. The ceiling is 23,000 ft. The climbing ability of the Goliath was demonstrated by several altitude flights which established new world records. These are: 20,664 ft., with five on board, April 1, 1919, 20,336 ft., with fourteen on board, April 3, 1919, 16,728 ft., with twenty-five on board, May 5, 1919. The latter climb was made in 1 hr. 15 min.

The internal arrangement of the cabin is shown in Fig. 3. Fourteen passengers are afforded accommodation in comforta-

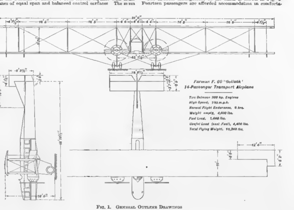


FIG. 1. GENERAL OUTLINE DRAWINGS

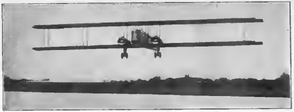


Fig 2 Nose-on View of the Farman Goliath in Flight. The Clean-Cut Lines of the Machine Are Noteworthy

ble wicker chairs, which are disposed in two rows and are separated by an aisle which runs all through the cabin The panel visible at the end of the left row of chairs is the rear wall of the pilot compartment, which is raised above the roof of the fuselage so as to afford the pilot an unrestricted view This arrangement is visible in part on Figs. 4 and 5, and may be plainly seen on the outline drawings

Figs. 4 and 5 illustrate in detail the mounting of the wing engines and the fitting of the fuel and oil supply. Behind each engine there is mounted a gasoline tank holding 400 liters (appr 100 gal) and an oil tank holding 35 liters (appr 9 gal), the two tanks are roughly stream-line shape, and so act as fairing elements for the engines. The fuel supply is sufficient for a flight of 6 hr at cruising speed

The fitting of fuel and oil tanks right behind the engine has the advantage of doing away with extensive piping, hence an important source of possible troubles in the gasoline feed system is eliminated As fuel is fed to the engines by gravity, complications due to mechanical trouble are also reduced to a minimum

For the France to West Africa flight, the Goliath was equipped with an additional gasoline tank of 1175 liters and an oil tank of 200 liters, both of which were fitted in the cabin, the number of seats, including that of the pilot, was reduced to eight, and a radio-sending and receiving apparatus was also fitted Owing to this re-fitting, the net weight of the machine was slightly raised, it being 4620 lb , while the disposable (fuel and useful) load was decreased to 5720 lb The total flying weight was thus 10,340 lb.

The crew selected for this flight was composed of two pilots (Bossoutrot and Coupét), a navigator, a radio officer, a photography officer and three mechanics—a complement of eight

On the first leg of the flight the Goliath flew, on Aug 11, 1919, from Toussus-le-Noble, near Paris, via Poitiers, Bayonne, Madrid and Gibraltar, to Casablanca, Morocco, a total distance in airline of 1100 sta. mi , which the machine covered in 17 hr 23 min Radio communication was maintained throughout the flight with various stations, and navigation was effected by compass, which enabled the machine in particular to steer a true course for some 700 mi. while flying over a continuous layer of clouds

Incidents en route comprised. one radiator-thermometer stopped functioning, one magneto drive pinion became unlocked, and one of the propellers was slightly cracked at the hub owing to the great heat prevalent during the latter stage of the flight

The engines were throttled down throughout the flight to

Fig. 3. Interior of the Passenger Cabin, Looking Forward

Fig 4 The Cabin Seen From the Side and the Left-Hand Engine With Its Wing Tank

1300 r.p.m , and the official report attributes to this fact the total lack of engine trouble experienced On landing there remained 110 liters of gasoline in the big tank, 120 liters in the right-hand wing tank and 125 liters in the left-hand wing tank, the total gasoline consumption was 1670 liters and the total oil consumption 120 liters The loss of water in the radiators was 3 liters.

On Aug 14, after having repaired the damaged propeller, the Goliath proceeded to Mogador, Morocco, 185 miles away; which it covered in 2 hours On Aug 15 the airplane started on the last leg of its flight to Dakar The machine took off at 4 p m , to avoid the great heat, and followed the African

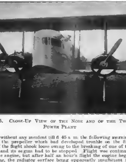


Fig 5. Close-Up View of the Nose and of the Twin Power Plant

coast without any incident till 6 45 a m the following morning, when the propeller which had developed trouble on the first leg of the flight shook loose owing to the breaking of one of the bolts and its engine had to be stopped Flight was continued on one engine, but after half an hour's flight the engine began heating, the radiator surface being apparently insufficient for the high temperatures encountered over the Sahara desert The pilot therefore decided to make a landing and this was effected on the beach of Afftouth, 75 miles from St. Louis, French West Africa, and 280 miles from Dakar. Owing to the restricted space available, the machine ran into the sea and was damaged by the breakers.

The crew saved its rations, arms, some of the instruments and the log and started out toward the nearest native settlement. On Aug 21 two Moors were met in the desert and these led the aviators to a nearby oasis, whence camel riders sent out by the French governor brought the airwrecked party back to civilization

The distance flown on the third leg of the great journey was 1,135 sta. mi and this was covered in 14 hr The total distance covered in this flight was 2,480 sta. mi

British Aircraft Competition

In connection with the British Aircraft Competition, the following engines for use by competitors have been approved by the Air Council

A. B C (all types), Beardmore 100 hp , B H P , Bentley Rotary (1 and 2), Cosmos (all types), Galloway Adriatic, Galloway Atlantic, Galloway Pacific, Green (all types), Napier Lion, R A F (all types), Rolls-Royce (all types), Siddeley Puma, Sunbeam (all types), Wolseley Viper.

The date for the competition has been changed as follows Airplanes (small type), March 1, 1920, airplanes (large type), May 1, 1920, seaplanes (amphibians), Aug 1, 1920

Tests of Synthetic Gasoline

Following apparently satisfactory test block studies of a synthetic airplane engine fuel known commercially as Alcogas and composed of 38 parts alcohol, 19 parts benzol, 4 parts toluol, 30 parts gasoline and 7½ parts ether, the Post Office Department arranged for a test of the fuel under service conditions in the Air Mail

Mail plane No 35, a Curtiss Model R4 machine equipped with a high compression Liberty 12 engine, was assigned for the work, the check plane, flying the opposite trips during the same period with high test aviation gasoline, being mail plane No 34, also a Curtiss Model R4 plane, equipped with a low compression Liberty 12 engine

The following carburetor settings were used.

	Alcohol Fuel High Compression Liberty	Gasoline Low Compression Liberty
Choke	31	31
Main Jet	145	145
Compensator	170	165
Well	100	100

Thirty-one trips were flown between New York and Washington, being 218 mi non-stop flights, on the regular Air Mail schedule between Aug 4 and Sept 16, 1919 The flights made by the gasoline ship numbered nineteen. The test was conducted under the direction of J C Edgerton, Chief of Flying and Testing, Air Mail Service

The tests indicate a saving of 3.3 gal of fuel an hour in favor of the alcohol fuel. Noting the revolutions per minute however, the saving is even greater, as alcohol fuel shows 1514.3 r.p.m. as against 1507 8 r.p.m with gasoline. This means that not only is there a saving of 3.3 gal of fuel per hour, but that 6 5 r.p.m are gained also by the use of the alcohol fuel

Alcohol fuel also shows a saving in lubricating oil The average for this fuel was 4.4 quarts per hr as against 4 98 quarts per hr for gasoline, or a net saving of .58 quarts per hr. This oil saving is thought to be due to greater thermal efficiency displayed by alcohol fuel as against gasoline. This does not appear on the face of the charts, due to the fact that high compression engines usually run considerably warmer than do low compression engines As the average on both tables show 167 deg , it is thus apparent that the alcohol fuel shows a relatively lower temperature

The following is the report of the field manager on the condition of the engine in plane 35 after the alcogas tests

"Carbon deposit was found to be from 1/32 to 1/16 in thick, soft and flakey Carbon was thickest on outside of piston crown showing it to be caused from oil rather than incomplete combustion of fuel Valves were all in good shape Valveseats showed no signs of pitting or warping No 6 connecting rod babbitt bearing cracked in both cap and rod Two piston rings were broken and six stuck in grooves. Motor in very good shape considering number of hours run"

The high compression engine used in plane No 35 during all of its flights on alcohol fuel was torn down after approximately 125 hr and was found to be in excellent condition The carbon deposited was less than that found in a motor using gasoline over a similar period of time

An analysis of the consumption of the alcohol fuel with various revolution speeds is as follows

1440 to 1460 r.p.m	15.9	gal.p.hr
1475 to 1480 "	20.1	"
1500 "	21 5	"
1520 to 1525 "	22 44	"

There follows comparative analysis of fuel consumption on gasoline and alcohol fuel at different engine speeds

Revolutions per minute	1440 1460	1475	1500
Gasoline		24	24 17
Alcohol fuel	15.5	20.1	21 5

There follows a comparative analysis of oil consumption at different engine speeds

Revolutions per minute	1440-1460	1475	1500
Gasoline		4.65	4.95
Alcohol fuel	4 5	4.2	4.2

Micarta Airplane Propellers

While wooden propellers are rather satisfactory in service, they are very subject to changes caused by climatic conditions and have to be handled very carefully and inspected frequently in order to avoid the bad results of warping. Wooden propellers also wear out very rapidly from the effect of sand and small stones near the ground and from the effect of rain in the air.

Aside from the features of wooden propellers which are not entirely satisfactory we also have to bear in mind the

A Micarta Airplane Propeller

rapidly growing shortage of wood and possibility that suitable propeller wood will be more and more difficult to obtain A great deal of experimenting has been done all over the world with a view of obtaining satisfactory propellers made of materials other than wood Most of the experiments have been made with steel propellers.

During June, 1917, at the start of the war research engineers of the Westinghouse Co. offered to cooperate with the Government in finding applications of Micarta products in the aircraft industry After a study of the physical properties of this material, it appeared as though Micarta ought to be a good material for propellers on account of its great flexibility.

As a result a design for a Micarta propeller for the Curtiss OX-5 was made by the Propeller Section at McCook Field and the Westinghouse Co was given an order to build several of these

A great deal of difficulty was encountered in building the first propeller on account of lack of suitable manufacturing equipment. The propeller was finally produced, however, and the first test showed some very wonderful results. This propeller designed for 100 hp withstood a test of about 800 hp. without injury

A great many of these propellers were tested with uniformly excellent results, and an order for fifty of them was placed with the Westinghouse Co These fifty propellers were finally delivered and sent to McCook Field also The design was a little heavy and it was decided to abandon this design and produce a propeller for a Liberty engine after providing suitable moulding equipment.

The Propeller Section worked up a design for the Liberty engine and the U S D 9 airplane based on previous experiments with the Micarta material. The Westinghouse Co. thus built an especially designed mould and press capable of exerting about a thousand tons pressure and provided with suitable heating coils for curing the material.

The first propeller came out of the mould in good condition and was given a whirling test in the testing plant which the Westinghouse Co was then operating for the Propeller Section After finishing the test at the Westinghouse Co., the propeller was brought to McCook Field and given an extremely severe whirling test, including a run of a few minutes at 1320 hp which was the most severe test ever given a propeller in the United States.

The propeller came out of the test in fine shape and was eventually destroyed in order to try its ultimate factor of safety.

The second propeller built for the Liberty engine was given a similar test and installed in a DeHaviland plane for flight test In comparison with the wooden propeller, the Micarta propeller showed a little better speed and climb, turning about 100 r.p.m slower This means that the propeller is considerably more efficient and a plane equipped with it will have a greater radius of action.

Following the flight test Sgt. Coombe used this propeller in the New York-Toronto Race

As compared with the wooden propeller, the Micarta has the following advantages greater efficiency, greater strength, greater resistance to wear when striking grass and sand and small stones, much greater resistance to the effect of rain and hail, less noise and many times greater life

In addition, it is absolutely unaffected by climatic conditions and can be used with equal success in the Great American Desert in New Mexico, or in the Philippine Islands, the humidity conditions in these places representing the extremes of dryness and moisture —From *Slipstream*

French Air Losses

From Aug 4, 1914, to Nov 11, 1918, the losses in the army zones were 1945 pilots and observers killed, 1461 missing, whose death may be regarded as certain, and 2922 wounded Outside the army zones, 1927 pilots and observers were killed, bringing the total losses in killed and wounded up to 7767 As the full strength on Dec 1, 1918, was 12,919 men, the war losses represent 61 per cent, which is believed to be the greatest proportion of losses in any arm of any of the Allied armies.

The DH-4B (Bluebird), Rebuilt for the Air Service so that the Pilot is Seated Behind the Gasoline Tank

The Fiat 600 H.P. Aircraft Engine

By Neil MacCoull, M.E.

It is only occasionally that we have the privilege of examining a new engine which reveals originality and initiative on the part of the designer in striking out boldly into departures not copies from other machines, and which does not savor of the "freak" Unfortunately there are too few really creative minds in the engineering world, yet there is a multitude who have good enough judgment to appreciate what is good and follow

A great majority of successful airplanes designed prior to and during the war followed the lead of the famous Mercedes in regard to valve arrangement and drive through bevel gearing as well as the built up welded steel individual cylinders.

Cylinders

The steel cylinders are built up by welding the valve cages and jackets together according to conventional Mercedes practice, even to the important detail providing the jacket water against the valve stem guides for their whole length as shown in Fig. 7 They are secured to the crank-case by twelve 10 mm (7/16 in.) studs, the lower portion of the barrel acting as a spigot in properly centering it, making doweling unnecessary. Four valves are provided for each cylinder, since it would be practically impossible to cool valves of larger diameter They are approximately $2\frac{7}{8}$ in. outside diameter (71 mm.) with a port diameter of about $2\frac{5}{8}$ in. (66.5 mm.) and have a lift of

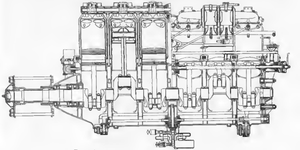


Fig 1. Longitudinal Section of the Fiat 600 Hp Engine

about 7/16 in. These valves are larger than those used in the Liberty ($2\frac{5}{8}$ in. outside) which ran continuously at a bright cherry red heat while in service, and are considered very close to the largest size permissible in this class of work A unique arrangement of valve springs shown in Fig 3 makes it possible to carry the camshaft housing very close to the cylinder head and makes a very neat compact job as Figs 2 and 7 will show. The two concentric springs and their cage are centered on a thin tubular guide with a disk-like flange at its lower end which in turn is centered by a shallow cup-like flange welded to the cylinder The weight of these valves and springs, etc, is $4\frac{1}{2}$ lb per cylinder, which makes the total cylinder weight $41\frac{1}{2}$ lb Each jacket contains two quarts of water. Each valve stem is actuated directly by a separate arm from a single rocker arm which is operated by a single roller The fulcrum is bushed and oscillates on a pin which is held in the cam-shaft housing by the same studs which hold it and its cover plates in place. As the valve arms and roller arms are not in line with each other, room is provided between them for a felt ring held in proper grooves in the housing and caps, which prevents leakage of oil. Reference to Fig 2 will make this clear.

The Fiat A-14 aircraft engine makes use of the same cylinder and fundamental valve arrangement, but differs widely in placing and driving of the auxiliaries. In fact aircraft engine design has almost crystallized into standardization about these principal parts and leaves but little room for the conservative designer to show his ability, except in the disposition of the auxiliaries in regard to accessability and neatness. This Fiat model gives one a feeling in this respect that the designer has thrown himself so whole-heartedly into his task as to create a real "atmosphere" about his work which may well be called a masterpiece.

With an engine of so great power as some 650 hp there is not much field for argument between the use of six or twelve cylinders on the grounds of smooth torque, etc, for more than 50 hp per cylinder may well be considered outside the limits of possibility at the present stage of the art, yet both the Mercedes and Maybach engines have proven this to be feasible. Accordingly the use of twelve cylinders is quite to be expected for this engine with a rated output of 600 hp. at 1500 r.p.m and a maximum of 720 hp at 1700 r.p.m The mean effective pressure was held to the conservative figure of 91 lb per sq in., which necessitated cylinders of a little over $6\frac{5}{8}$ in. bore by $8\frac{1}{4}$ in. stroke, having total displacement of 3490 cu. in. The piston speed at 1500 r.p.m. is 2070 ft. per min.

Pistons

Aluminum pistons are used, weighing slightly more than $6\frac{1}{2}$ lb complete. The rings have plain 45 slots, but adjacent

rings are slotted in opposite directions The bosses are bushed with bronze and provide bearing surfaces for the wrist-pin. Fig 4 shows the forked connecting rods, the inner rod being lined with a hardened steel bush which oscillates on the babbitt lined bronze bush clamped by the forked rod. A reinforcing strap connects the two caps of the latter rod. The crank-shaft is of orthodox seven bearing design, though it weighs 212 lb., including the ball and thrust bearings at the propeller end,

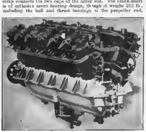


Fig 2. Three-Quarter View

because of its size, the bearings being 3 3/16 in. diameter The crank-case too is conventional, being split horizontally on the center line of the crank-shaft, the lower half containing the lower bearing brasses. Five breather tubes are located in the V directly above the main bearings (Fig 1.)

Bearings and Drive Shafts

One of the first departures from customary design is the center main bearings, like that of the Rolls-Royce, which is

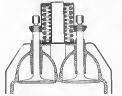


Fig 3. The Dual Valve

given a length approximately 60 per cent greater than the other main bearings, because analysis shows that this additional length is necessary in order to keep the loading per sq. in. the same for all bearings as is necessary if no one bearing is to wear faster than another. Advantage is taken of the additional space between the third and fourth cylinders resulting from lengthening the engine to accommodate this bearing, by locating in it the drive shafts for the cam-shafts. The immediate result of this arrangement is that each cam-shaft is driven from its middle and its torsional deflexion and vibration thereby reduced greatly and both ends of the engine are free for the symmetrical location of the magnetos It is always a difficult matter to properly locate four magnetos in accessible positions. The drive-shafts are inclined at a greater angle than the cylinders so as to mesh with a common bevel gear on a hollow shaft parallel to, but above the crank-shaft, and driven from it by a spur gear and idler as is clearly shown by Figs. 1 and 7 The length of the hollow shaft and its small diameter give it a slight amount of spring which smooths out the shock

Fig. 4 Assembled Connecting Rods

to the gearing caused by any torsional vibration of the crank-shaft, which is supposed to be the cause of several gear failures of a well known engine having no flexibility of this sort. Another excellent design feature is that each pair of bevel gears is self contained as a unit in its alignment so as to be independent of any unequal expansion of shaft and housing which might wedge the gears if they were all fixed to their drive shafts and with no freedom to slide. The housing for

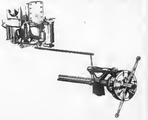


Fig. 5. Throttle and Altitude Controls

the bevel gears between each cam-shaft and its drive shaft supports a worm driven air pump of 1½ in. bore and stroke.

Ignition

In order to assure rapid flame propagation four spark plugs are provided for each cylinder, and ignition is furnished by four twelve cylinder magnetos, each magneto being connected to one plug of each cylinder so that the engine should run even though three of the four magnetos fail A plan view

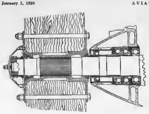


Fig 6. Cross Section of Propeller Hub and Mounting

of the unusual drive of the magnetos is shown in Fig. 8. Each pair of magnetos is driven from a self-contained bevel gear which is splined to a shaft which is free to slide in it, and which passes through the hollow shaft of the cam-shaft drive group The former shaft is driven by the latter through helical splines, so that as it slides laterally it will rotate with respect to the other thus the spark advance is accomplished Not only will all magnetos be assured of equal advance or retard, but an equally hot spark will be secured at all positions which cannot be accomplished when the spark of standard magnetos of the Bosch type is adjusted by means of rotating

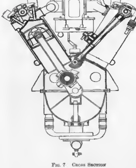


Fig. 7 Cross Section

the breaker box. Notice the length of the small diameter tubular shaft which drives the magnetos. It is sure to spring a little in service and automatically retard the spark as the speed increases though it assures a smooth drive; but fortunately all magnetos will be retarded equally and this springing may be compensated by a little further movement of the control lever As may be seen from the figure, spark advance is controlled by the oscillation of a lever which slides

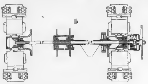


Fig 8 Horizontal Section of Magneto Drive

the magneto drive shaft by means of the large thread and nut arrangement at the right. Switches are provided for grounding all, either pair, or any single magneto, and for connecting a battery and vibration when starting

The accessibility of these magnetos and the ease with which they may be removed should appeal to the practical man, as well as the ease of removing the magneto drive shaft if necessary.

Carburetors

Two double water jacketed carburetors are located in the "V" between cylinder banks. Their most interesting feature is the altitude adjustment consisting of a needle projecting downward, which is lowered into the main jet by rotating the cage holding it as shown in Fig 5 for one of the four jets. This figure as well as Fig 1 shows the neat means for operating the altitude adjustment by a drum and cable The drum

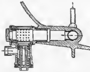


Fig 9. Oil Pressure Regulating Valve

rotates on a shaft extending through the "V" to which levers are connected which operate the cylindrical throttle shown in Fig 1. At the top of the right hand carburetor will be seen a small bevel connection to a horizontal shaft from which a crank is linked to a crank on the control shaft of Fig. 5 which in turn is secured to the lever shown.

Lubrication

In the lower half of the crankcase are two horizontal shafts in line driven by an idler from the same spur gear on the crank shaft which drives the magneto and cam shaft groups (see Fig 1) These shafts drive the gear type oil pumps, the for-


The Curtiss Three-Passenger ORIOLE


The Curtiss Three-Passenger SEAGULL—Flying Boat

The Curtiss Eight-Passenger EAGLE—An Aerial Superlimousine

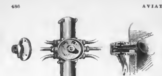


Fig 10. Distributor Valve and Check Valve of the Air Starter

each bank of cylinders. Water connections extend up through both halves of the crank cases by means of passages cast in them. At the top a short "T" connects with short water inlet tubes welded to the water jacket of each cylinder. These tubes are all connected together by rubber hoses. The unusual neatness of this design is revealed in Fig 2. The water outlets of each group of three cylinders are connected in series, there being a total of four outlets leading to the radiator.

Starting

Compressed air is used for starting this engine because it is much lighter than any electric device could be which would have power enough to turn such a huge engine over. In Fig 7 is shown a distributing valve mounted on each cam-shaft drive shaft. Air is distributed by a ground disk valve and lead to each cylinder by means of the poppet check valves shown. Diagrammatically the arrangement is given in Fig 11, in which *A* is a supply tank carried on the plane, *B* is a "triple valve" connecting the tank *A* either to the distributing valves *D* or to some other outside source such as *F* from which the tank *A* may be charged before leaving the ground.

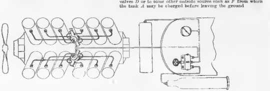


Fig 11. General Arrangement of Compressed Air Starting System

ward one being a scavenging pump only while the other is a combination scavenging and pressure pump mounted one above the other. The pressure pump takes oil from an outside tank and after passing the pressure regulating valve of Fig 9 delivers it to the main bearings from which it reaches the crank-pin bearings by way of the passages drilled in the crank shaft. The cylinders and wrist pin are lubricated only by the oil sprayed on the main and crank pin bearings. Former Fiat engines led an oil pipe from the lower to the upper connecting rod bearing, and its elimination in this engine is apparent proof that it was found unnecessary.

A branch from the supply of oil to the main bearings is taken to the end of each cam shaft, and drains from the housing back to the crank case through four small tubes located between the cylinders of each bank. The very small tubing shown in Fig. 2 for the cam-shaft oil supply makes one wonder if this engine is supposed to operate in cold weather when oil may be as thick as grease. Of course it is usually warmed before being poured into the engine when starting in cold weather, but oil in a tube this size would cool off at such a rate as to be in danger of starving the cam shafts. All oil drains back into the crank case, from which it passes through screens to the scavenging pumps which send it through a radiator and then into the supply tanks as shown on Fig 12. The proper cooling of oil for a high powered aircraft engine, particularly on this size, can hardly be over emphasized. It is worthy of notice that the oil pumps are very accessible and may be replaced easily if necessary. Another point is the extensive use of ball bearings on all auxiliary shafts and gears and even for the oil pumps.

The two halves of the oil pump drive shaft are connected by means of bevel gears meshing with a third bevel on a hollow vertical splined shaft as can be seen in Fig 1. A splined end of the water pump shaft projects up into this hollow shaft, and is driven by it making it possible to remove the pump without disturbing any of the gears. The pump has a double runner and discharges two separate streams of water, one for

General Data

Bore, 178 mm. (6.693 in.)
Stroke, 210 mm. (8.268 in.).
Ratio, 1 235
Clearance volume, 1260 cu. cm. (76.89 cu. in.)
Compression ratio, 4.687.
Valve timing, inlet open 8 late, inlet closes 48 late, exhaust closes 6 late.
Horsepower rated 600 at 1500 r.p.m.
Weight of engine complete dry 1783 lb (including propeller boss).
Weight per hp dry, 2.06 lb
Weight of water in engine 60 lb.
Firing order facing propeller end, 1r, 6l, 5r, 2l, 3r, 4l, 3r, 1l, 2r, 5l, 4r, 3l
Oil pressure, 1½ atm.
Oil pressure, 75-80 atm

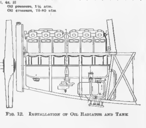


Fig. 12. Installation of Oil Radiator and Tank

Airplane Wing Coverings

By Lieut. Charles J. Cleary, A.S., A.P.
Textile Branch of Material Section, Engineering Division, A. S

In the early stages of aviation little attention was paid to the textile materials used on an airplane. Further than insisting upon a wing covering of silk or linen nothing was specified. The weight per unit area of the fabric, the texture, weaving, the number of threads to the inch in the warp and the filling, and the question of elasticity in the warp and filling, were all neglected, presumably because everyone assumed that a fabric of silk or linen supplied every need of an airplane wing covering. Due to chance, or possibly by design, such fabrics were chosen having a factor of safety sufficiently high to be partly, if not wholly, satisfactory.

Concerning the use of silk, it may be said that, as far as weight and strength were concerned, this material was entirely satisfactory. Its application also gave little trouble and for some time silk was the most extensively used of all fibres as

Fig 1. Reinforcing Tape in Place for Lacing

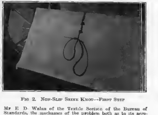


Fig 2. Non-Slip Seine Knot—First Step

airplane fabric. The chief effect of dope on silk was greatly to reduce its resistance to tearing, owing to the fact that the dope holds the individual yarns securely in place and permits of little or no slippage, or "fabric assistance." This results in nothing more than a successive shearing of the individual threads which, under the conditions, must necessarily be small. The same fact holds true for linen and cotton fabrics, but the increased diameter of the individual threads in both these fabrics give much higher values to their tear resisting qualities. With the development of aeronautics, the limited supply of silk also made it necessary to secure some other material with a more extensive source of supply.

Linen fabric was found to be more satisfactory than silk in many ways, chiefly as to the cost and also to the fact that the supply was believed to be practically unlimited as far as aviation needs were concerned. The tensile strength of linen was higher than for silk, although it was considerably heavier. The tearing resistance was very much greater after doping than silk in the same condition, so all things considered, it was entirely reasonable that general practice in the early days of aviation favored the linen fabric rather than the silk as an airplane covering.

Some effort was made to use a cotton fabric, but, possibly due to lack of appreciation of the mechanics of the problem or other causes, the choice of fabrics was not fortunate and the results obtained from these efforts, especially after the fabric was doped, were such as to discourage all further attempts at the use of cotton. The impressions created by these efforts left an effect which was lasting and which resulted in a prejudice not easily overcome.

With the extremely rapid development of aviation due to the Great War, it was early made evident that the supply of linen, especially after the political breakdown of Russia, would not be sufficient to meet the needs of the various air programs laid down by the several allied countries. This situation was brought to the acute stage by the entrance of the United States in the war. Efforts were made at once to develop a cotton fabric which would be a satisfactory substitute for linen, and before long Italy and England had produced fabrics of cotton which were more or less satisfactory, although they did not equal the linen covering, as far as performance was concerned.

In the spring of 1917, when the magnitude of the American air program was appreciated, it was at once apparent that the supply of linen would not begin to meet the demand, and that the need of a substitute, preferably cotton, was an immediate necessity. To this end, several of the leading textile manufacturers were consulted by the Bureau of Standards and representatives of the U. S. Air Service. Through the efforts of Mr. E. D. Walen of the Textile Section of the Bureau of Standards, the mechanics of the problem both as to its aeronautic and textile phases, were presented to the manufacturers and work was commenced at once on several experimental fabrics which were to be tested first in the laboratory and then in actual flight. As usual, in work of this sort, the initial attempts were not entirely successful, but enough information was obtained to indicate that a fabric made of cotton was entirely practicable, and in a comparatively short time two classes of cotton fabric, one for use on training planes and the other for use on combat machines, were in production.

Methods of Covering Aerofoils of an Airplane

There are two general methods of covering a wing with fabric:

(a) Strips of the fabric are cut sufficiently long to permit of their passing from the trailing edge over the top of the wing around the entering edge and back underneath to the trailing edge, where both ends of the fabric are held together preparatory to hand sewing the seam, which is always placed at all trailing edges. A number of strips, sufficient to completely cover the wing its entire length, are then sewed together by machine, using a silk or fine linen thread and stitched in a double row for strength. The cover, in the form of a sheet, is placed on the wing with the seam at the trailing edge, as previously described, and is held at the trailing edge by pins or tacks, ready to be given its initial tension preparatory to sewing the cover together at the edges. Every fabric has certain initial tension limits which determine, in a measure, its most satisfactory performance when on an airfoil and when covered with dope. These limits can only be determined by actual experience with the different fabrics, both of cotton and of linen, each of which, owing to differences in construction, has a different amount

of stretch. As a general rule, the greater the stretch in a fabric the tighter the fabric must be pulled for its initial tension. Unless these satisfactory working limits are known, the stretch in the fabric will be greater than the stretch in the dope, and as a consequence the machine will be "riding on the dope." The usual limits of the initial tension of standard cotton airplane fabrics are from 1½ to 2½ lb. per linear in. The fabric is now ready to be hand sewed at the seam, which is at both ends and the trailing edge of the wing.

This method is slow, but fine work can be done when it is used. It is also the best method to use in experimental work.

(b) The envelope method is the second method and is done by cutting the fabric according to patterns and sewing it up by machine, leaving both ends open to permit it being drawn onto the frame, envelope fashion. The envelope is smoothed out and tightened on the frame by pulling at both

FIG 3. NON-SLIP SEINE KNOT—SECOND STEP

open ends. These open ends are temporarily tacked and then sewed by hand.

When production is desired, this is by far the best method to use.

All metal parts of airplane frame-work which will be in contact with fabrics should be wrapped with cotton or linen tape to protect the fabric from the action of rust. This fabric is held in place by a light dope coating.

Method of Obtaining Initial Tension

Temporary tacks are driven through the cover on the under side of the leading edge, *at each fore and aft seam only*. The wing is then turned top side up and the operator starts at the trailing edge to pull the cover gradually tighter from one end of the wing to the other. If the wing has a wooden trailing edge, tacks are used temporarily to retain the tension given by the hand pulling. If the wing has a metal trailing edge, it is first wrapped with cotton or linen tape and the cover is pinned to the tape wrapping. As the operator pulls the fabric and tacks or pins he folds under the raw edges in preparation for hand sewing. The wing is next turned over and the other side is treated in the same manner. It is well to leave about ¼ in. space between the two edges to be sewed, so that none of the tension will be lost during the sewing operation. The importance of initial tension cannot be denied, as it is one of the numerous factors affecting the vibration of the wing covering during flight.

Lacing the Fabric to Aerofoils

Lacing is a very important operation, as the attachment to each rib affords a line of support for the fabric, lessening the effect of vibration.

The method of fastening to each rib is as follows: Tape, the width of the rib cap strip, is placed on the rib over the fabric and is held in place during lacing by tacks, which are extracted when the operation is complete. This tape is placed on the upper and lower side of the wing. Lacing extends along the entire rib, starting at the trailing edge and extending as near the entering edge as possible. The lacing cord passes completely around the rib from top to bottom and is knotted at the top in a non-slipping knot, which permits of minimum vibration. The cord then passes along the top of the rib to the next point, which is usually about 4 in. distance. The pitch of the lacing fastenings on that part of the wing which is directly in the air blast of the propeller, is about 2 to 2½ in., as an additional precaution against the excessive vibration due to this air blast. The only satisfactory non-slipping knot is the one known as the "seine" knot, and a study of the accompanying illustration showing the different stages of this knot will demonstrate it sufficiently to permit of duplication.

A cotton or linen tape, about 2½ in. wide, is put on over the lacing cord after the first coat of dope is applied. The only way in which the finishing tape is held fast is by the adhesion of the dope. The purpose of this finishing tape is to present a smooth surface for the uninterrupted flow of air.

With the fabric as attached to all of the aerofoils, doping is the next process.

With respect to covering the fuselage, no particular method is used. It is a simple mechanical problem which can readily be solved in practice.

Dopes and Doping

To a certain extent, the purpose of airplane dope is to produce an impervious and smooth coating on the fabric, but its most important function is the production of a satisfactory tautness. The mechanism of this action is two-fold. There is a shrinkage of the dope film, not a shrinking of the fabric in the ordinary sense, but a powerful contraction on the part of the dope film during the process of drying. If the initial tension is right, the dope does not affect the fabric, only in so far as it lessens its flexibility. The wing cover could not become tighter from doping without exerting the pull on the wing framework. Experiments have conclusively proven this to

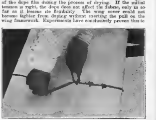


FIG 4. NON-SLIP SEINE KNOT—THIRD STEP

be the case. In addition to this, films of dope and strips of doped fabric stretch very much less than strips of undoped fabric under a given tension, provided this tension is below the elastic limit of the dope. Therefore, doped fabric is very much less deformed by the pressure exerted upon the wing during flying than undoped fabric would be.

The fundamental constituent of the dope is a film-forming gelatinous substance, which has been cellulose nitrate or cellulose acetate in all commercial dopes. Cellulose nitrate, which is also the base of ordinary celluloid, is a very highly inflammable material, and its use has been prohibited on military airplanes in favor of less inflammable, although more expensive, cellulose acetate.

The film-forming constituent is dissolved in a volatile solvent, of which acetone is the type. Since certain non-solvents, such as benzol and alcohol, are cheaper than the solvents, and since a considerable proportion of them may be added without injurious effect, dopes usually contain such materials which are called "diluents." In order to prevent "blushing" or whitening during the application of the dope, a "high boiler" is

necessary. This is a solvent liquid whose boiling point is considerably higher than that of water. Finally, there is necessary to produce a durable dope, a certain proportion of plasticizers. These are substances of low volatility, not necessarily solvents, which soften the film and make it tougher. A high boiler will usually also function as a more or less temporary plasticizer, but its primary function is the prevention of "blushing."

One of the greatest enemies of good doping is high humidity. If water is added to a dope solution, a point is reached at which the film forming constituent is precipitated from solution in an opaque porous form of little strength. This reaction is known as "blushing." During the drying of dope the rapid evaporation of volatile solvents produces a marked cooling effect, and there is a great tendency for water to be absorbed from the atmosphere. If this absorption reaches a sufficient amount, precipitation takes place with the formation of white areas in which the dope very soon disintegrates. A high boiler counteracts this because it evaporates more slowly than water does and keeps the film forming constituent in solution until the water has a opportunity to evaporate. Cellulose

FIG. 5. NON-SLIP SEINE KNOT—FINISHED

acetate is a material of more recent development than cellulose nitrate, and there has been some difficulty in developing suitable "high boilers." For this reason, some of the earlier acetate dopes contain no "high boilers" at all and can be applied without "blushing" only under conditions of very low humidity. This accounts for a large part of the prejudice against acetate dope, but more modern examples are quite as satisfactory as the nitrate dopes in this respect. The matter of adding "high boilers" in the proper quantity is fully and completely taken care of in the manufacture of the dope and under no circumstances, should any attempt be made at flying fields or factories to affect the quantity of "high boilers" present in the dope. A careful consideration of the matter of relative humidities during the various stages of application of fabric and dope will furnish the proper solution of difficulties due to "blushing." In any case, very great care should be taken to keep the humidity as low as possible, in a closed building by increasing the temperature over that existing outdoors. In particular, the fabric before doping should be kept at the same temperature and humidity as that in the doping room. (Temperature 70 to 80 deg. Fahr. Relative humidity 50 to 60 per cent.) The reason for this is that if the relative humidity in the covering room be higher than the relative humidity in the doping room, the fabric will give off moisture until it comes to equilibrium with the moisture in the doping room. This would mean a slacking of the fabric. The ideal condition would be for the relative humidity in the covering room to be slightly lower than that of the doping room. This would permit the fabric to become slightly tighter in coming to equilibrium with the moisture in the doping room.

The tautness of the doped fabric depends, to some extent, upon the weight of the dope film applied. With a satisfactory dope, however, suitable tautness should be obtained in not more than five coats and the weight required should not exceed 2.75 oz. per sq. yd.

Since the solvents in use in dopes are highly volatile, it is important to keep dope in tightly closed containers, otherwise the concentration due to evaporation may easily produce a solution too viscous to be applied by a brush.

Both cellulose acetate and cellulose nitrate undergo a serious deterioration when exposed to sunlight, becoming brittle and finally completely disintegrating. This deterioration is little, if any, lessened by a transparent varnish, but a great deal of protection is afforded by a pigmented coating, which may be either oil enamel or a pigmented dope. The pigmented dopes have the advantage of very much more rapid drying, but in any case the important thing in selecting a colored coating for airplane wings is a very high flexibility. House paints or automobile body enamels go to pieces in a very short time.

Application of Dope

The proper application of dope to an aerofoil is possibly easier to explain than it is to actually perform. Temperature and relative humidity must be considered both at the time of covering an aerofoil with fabric and at the time of the application of dope, if the coating of dope is to remain clear, and if "blushing" of dope is to be prevented.

The usual procedure is to apply five coats of an "acetate" dope by hand, waiting a half hour or more between coats to permit good drying, and the results of this method in practice have been eminently satisfactory.

One of the most satisfactory methods of dope application hit upon by actual experiment and results watched during use is to apply the first coat in the thinnest possible layer, hardly more than a general dampening of the fabric, and four or five subsequent layers to be of the usual thickness. This seems to establish a better bond between the fabric and the dope film, and affects the tear resistance of the doped fabric less than any other method which has been tried.

The theory of the bond between fabric and dope film has come in for considerable discussion recently, and an attempt will be made in this paper to specifically examine what the correct theory is, but it is apropos to say that partial or complete penetration of dope into the fabric is not desirable in that it affects the fabric's physical properties more than a union between the dope film and the surface of the fabric. This effect is obtained by the application of the extremely light first coating, as previously explained, which forms a base for the other coats and prevents excessive penetration.

Requirements of Airplane Fabrics

After a consideration of the methods of applying, fastening and doping the fabric on the aerofoils of an airplane, a better understanding of the needs and requirements of airplane fabrics can be arrived at.

The general practice of today requires that the following properties be contained in an airplane wing covering:

(a) Relatively high tensile strength both in the warp and in the filling.

(b) High resistance to tearing as determined by several common methods.

(c) Low weight per square yard of the material.

(d) Less stretch in the filling threads than in the warp threads.

(e) The weave, texture and finish of the fabric to be such as to permit of a good bond between it and the dope.

Tensile Strength

This is required to be high because the yarns are in tension at all times during flight, and it is desired to have the minimum fatigue effect due to repeated or continued stresses in the material.

Tearing Resistance

The need for this is self-evident. In the event of a rupture or tear in the fabric, it is desirable that the tear or rupture be kept to minimum size to preserve the contour of the wing section and to give every possible advantage to pilots.

Low Weight

Low weight in an airplane wing covering is highly desirable. The fabric used at the present weighs from 4 to 5 oz. per sq. yd. The tendency is toward even lighter fabrics and in view of experimental work already done it will not be surprising if a material weighing only 2½ to 3 oz. is found to be suitable for some types of planes. There is a marked trend at the present along the lines of a fabric having heavy filling threads and light warp threads, which will permit of a slight reduction

in the weight of the covering per unit of area. This particular fabric construction was discussed at length in the *Textile World Journal* some time ago. In general, it may be said that when a fabric of this type is used care should be used in determining the distance between ribs in the wing, which will depend largely upon the relation between the strength and stretch of both systems of threads in the fabric. In view of the additional care involved in the application of this fabric, it is the opinion of the writer that the slight advantage in weight does not warrant the adoption of the new type fabric.

The question of stretch is of greater importance than would at first appear. To emphasize this point, it is necessary to go slightly into details, but the question is of sufficient importance to warrant the digression.

To permit ease of handling and for the sake of production in its application, the fabric is applied to the wing with the warp threads parallel to the line of flight, and the filling threads running from rib to rib The warp threads are parallel to the selvages and run lengthwise in the fabric The filling threads are the cross threads When the fabric is applied, it is laced to every rib, which means that the filling threads are supported at intervals of 14 in. or less (usually much less), while the warp threads are supported only by the leading and trailing edges, so far as stretch is concerned. The supporting rectangle outlined by the two adjacent ribs and the leading and trailing edges must be given consideration, especially with reference to the question of stretch of the warp yarns and the filling yarns. When the fabric in this rectangle is under pressure, the stress in each system of threads depends upon the deflection of each system in their respective directions If it is desired that the stress shall be equally distributed, it is necessary that the filling yarns shall have greater stretch than the warp yarns, and this difference will depend upon the relation between the distances from leading edge to the trailing edge, and the distance from rib to rib

If care is not given to this question of stretch it is more than probable that failure of the fabric will be materially hastened

Reinforcing Tape

With reference to the reinforcing tape that is used on the rib cap strip, as an additional reinforcing, its purpose is self-evident If it were not used the lacing cord would cut through the fabric in a short time due to the vibration of the fabric and the results would undoubtedly be serious, as was the case in the early experiments with high powered motors in planes. This reinforcing tape has practically all of its strength in the warp direction, to resist the shearing tendency of the lacing cord.

Lacing Cord

The lacing cord used in the best practice is a 9 cord linen or a 20/3/3/3 cord of Egyptian or Sea Island cotton High strength, of course, is desirable, but its chief property should be a high resistance to fraying This can easily be appreciated when its function on a plane is considered.

Methods of Testing Fabric

In testing an airplane fabric to determine its physical properties, all tests are made under known and controlled atmospheric conditions of 65 per cent relative humidity at a temperature of 70 deg Fahr The following determinations are made

(a) Threads per inch, in warp and filling
(b) Weight in ounces per square yard.
(c) Stress-strain diagrams are plotted on an autographic tensile strength machine.
(d) Tearing tests by several methods.

From the nature of the determination, (a) and (b) of the above require no further explanation, (c) is used to determine the breaking load for the particular fabric, and the stress strain diagram shows the relative stretch in the warp and in the filling of the sample, (d) There are two kinds of tears in general in an airplane fabric—one in which a hole has been punched as by a bullet, and the other where a flap protrudes in the air blast and has a tendency to tear back to the trailing edge The conditions of the first are approached as nearly as can be in the laboratory by subjecting a punctured sample to known pressures, and measuring the pressure required to continue the original rupture, and the deflection of the fabric due to the application of this pressure

The conditions of the second tear are approached by recording the actual pull in pounds required to continue the tearing

French Subsidies for Transport Aircraft

The French Government has decided to give financial support, annually, to French enterprises in aerial navigation, which have been legally formed and which have set up a public service, whether it be regular or irregular

The subsidies will be applicable for the period Aug 1 to Dec 31, 1919. They are divided into four categories.

(a) Subsidy for deterioration of the machine
(b) Subsidy for equipment
(c) Subsidy for transport
(d) Military subsidy

The subsidies are calculated according to the hours of flight. The subsidy for deterioration is given by the formula

$$\frac{(P + 1.5\ p)}{400}$$

where P is the price of the body and p of the engines The state pays half the deterioration in the case of a regular transport service when the itinerary connects two points more than 200 kilometres distant—that is to say, 0.00125 $(P + 1.5\ p)$.

To enterprises which carry on an irregular service, connecting two points more than 50 km. distant or enclosing a circuit, without landing, of at least 100 km., or to enterprises with a regular service, but connecting points less than 200 km., the state pays a quarter of this deterioration, that is 0.000625 $(P + 1.5\ p)$ The prices P and p are fixed by the state For machines made over by the state, P and p represent the price of cession.

Subsidy for equipment The state pays according to the length of an average non-stop journey, in the first case, and the longest non-stop journey, in the second case, at the rate of 0.10 per km and according to the hp of the machine at the rate of 0.05 per hp in the first case and 0.025 per hp in the second case

Transport subsidy This is proportional to the speed V of the machine itself, (1) to a speed v equal to $V - 50$, (2) to the capacity T of useful tonnage, to a coefficient K. This is written $0.0K \times V \times v \times T$.

The coefficient K varies according to the nature of the undertaking In the second class K equals zero. For enterprises which have international and regular transport $K = 14$. For those which assure a regular transport service between France and the Colonies, connecting France with North or Western Africa, or penetrating the African interior, K is determined by the nature of the enterprise and the length of the journey according to the following table:

Length of average journey	250 and below	250 to 500.	500 to 750	750 to 1,000	1,000 and Above.
France	12	16	14	15	16
Colonies	13	14	15	16	17
French North Africa and Western	14	16	16	17	18
Interior	16	16	17	18	19

Military subsidy The state gives a supplementary subsidy for deterioration for all machines which have a military value, equivalent to a quarter of the deterioration, that is 0.000625 $(P + 1.5\ p)$. Companies and individuals thus subsidized must be of French nationality and the material employed of French manufacture The machines used must possess a certificate of airworthiness and be maintained in a perfect state for flight The pilots must have a license for public transport or for aerial touring, according to the nature of the undertaking Public tariffs are determined by the state The state also fixes the minimum number of pilots, mechanics and machines to be used Three times the number of machines in general use are requisite and half as many pilots as machines. The enterprises which guarantee a regular service on a course of more than 200 km must maintain that service or be disqualified for the larger subsidy, but departures can be postponed or abandoned by agreement in case of bad weather

$27,000,000 for Naval Aviation

The recommendations for the naval building program of 1921 provide for aircraft construction, including experimental development, but excluding cost of maintenance of the existing naval air fleet, a sum of $27,000,000 Of this appropriation it is proposed to spend $11,000,000 on heavier-than-air craft, $10,000,000 on lighter-than-air craft and $6,000,000 on experimental construction

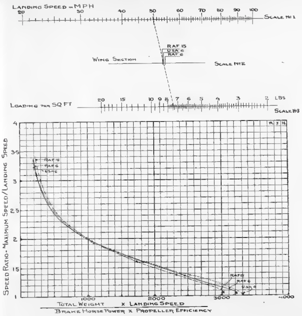
Selection of a Wing Section

By Raoul J. Hoffman, A.M.E.

A simple way of selecting a wing section will be found by taking the main factors of an airplane into consideration: the total weight, the brake horsepower, the propeller efficiency and the main performance characteristic: the landing speed. With the aid of these factors the performances (the maximum speed area and the ceiling) can be found

The following symbols will be used:

W = the total weight of the machine fully loaded in lb.



A = the area of the wings in sq. ft.
BHP = the brake horsepower of the power plant
e = the efficiency of the propeller
V = the velocity with power on in m.p.h.
V_L = the landing speed in m.p.h.
K_y = the lift in lb. for one sq. ft. one m.p.h.
K_x = the drag in lb. for one sq. ft. one m.p.h.
.0032 = resistance in lb. for one sq. ft. flat plate one m.p.h.
a = the area of a flat plate giving the same resistance as the non-lifting parts of the machine.

Writing the fundamental equations for

$$V = \sqrt{\frac{W}{A K_y}} \quad \ldots (1) \qquad V_L = \sqrt{\frac{W}{A K_y Max.}} \quad \ldots (2)$$

$$375\, B.H.P.e = \frac{W V (K_x + .0032\, a/A)}{K_y} \quad \ldots (3)$$

$\frac{a}{A}$ = the ratio of the detrimental area to the supporting area, denoting the efficiency of the design, and this efficiency will be assumed as 1/40. Substituting this in equation 3 and dividing both sides by V_L we will have

$$\frac{375\, BHPe}{V_L} = \frac{W V}{V_L} \; \frac{(K_x + .00008)}{K_y} \quad \ldots (4)$$

$$\frac{V}{V_L} \text{ being equal to } \sqrt{\frac{K_y Max}{K_y}}$$

we find for $$\frac{W V_L}{BHPe} = \frac{375}{\sqrt{K_y Max.}} \; \frac{K_y^{3/2}}{K_x + .00008} \quad \ldots (5)$$

To compare wing sections we compute the design constant

$$\frac{375}{\sqrt{K_y Max}} \cdot \frac{K_y^{3/2}}{K_x + .00008}$$

for each angle and plot it as abscissæ, and for the ordinates, the corresponding $\sqrt{K_y Max}/K_y$.

In the accompanying chart, the three most used wing sections, R.A.F. 6, R.A.F. 15 and U.S.A. 0, are plotted.

To use the chart we determine the design constant for the machine, $\frac{W V_L}{BHPe}$ and find on the chart the speed ratio at the ceiling which is noted along the wing section lines. Knowing the landing speed, the maximum speed can easily be calculated.

To find the required area we draw a line through the landing speed on scale No. 1 and the selected wing section on scale No. 2, this line intersects the scale No. 3 at the loading per sq. ft. required. The total weight divided by the loading per sq. ft. gives us the necessary supporting area.

Each wing section has a maximum design constant (Exp. R.A.P. 6 = 3050) which gives us the minimum horsepower required for straight flight by using the formula $\frac{W V_L}{BHPe}$.

Knowing W, V_L, we can determine $BHPe$ the propeller $H.P.$ required, having a maximum BHP and an expected propeller efficiency (60 to 65 per cent) for climb, the difference gives us the horsepower available for climbing in the first minute using the formula

$$\text{Climb} = \frac{\text{Reserve horsepower} \times 33{,}000}{\text{Total weight}}$$

Example: W = 1900 lb., $B.H.P.$ = 90 hp., e = 70 per cent for maximum speed, e = 60 per cent for climb, V_L = 50 m.p.h.

The design constant for maximum speed $\frac{W V_L}{BHPe} = 1370$

We find on the chart for U. S. A. 6 a speed ratio of 1.8, than the maximum speed $45 \times 1.8 = 81$ m.p.h.

The maximum climb will be found by taking the maximum design constant and determining the $BHPe$ which will be 25 hp., the maximum available hp $= 90 \times 60 = 54$, thus the reserve horsepower is $54 - 25 = 29$ hp. and the climb in the first minute

$$\frac{29 \times 33{,}000}{1900} = 505 \text{ ft.}$$

"Doping Airplane Linen"

Owing to the difficulties created by the late printers' strike, the name of the author of the above-named article which appeared in the Oct. 1, 1919, issue of AVIATION AND AERONAUTICAL ENGINEERING was misprinted. The correct name of the author is Geo. H. Hopp.

Book Reviews

THE FLYING SPY. By Lieut. Camillo de Carlo, of the Italian Army. With a preface by Maj.-Gen. Emilio Guglielmotti. (E. P. Dutton & Co., New York. 402 pp.)

This is the diary of an Italian army aviator who volunteered to go on "special mission" behind the Austrian lines at the time the armies of the defunct dual monarchy had penetrated as far as the Piave river and were preparing for a final onslaught on Italy. How the "flying spy" succeeded in landing in the midst of the enemy, how he obtained valuable information, and after conveying it to his superiors made a successful escape, makes extremely thrilling reading, the authenticity of the story is backed by official documents and is indorsed by the Italian military attaché in Washington, D. C.

LUBRICATION OF THE MOTOR CAR CHASSIS. By Victor W. Page. (Norman W. Henley Publishing Co., New York. 24 x 38 ins.)

The chart presents a plan view of a typical six-cylinder chassis or standard chassis, and all parts requiring lubrication are carefully indicated. For each part, frequency of lubrication and kind of oil to be used are indicated.

THE DESIGN AND CONSTRUCTION OF AERO ENGINES, by C. Sylvester. (Aeroplane and General Publishing Co., London. Illustrated with diagrams.)

The book is based on a course of instruction given during the war to technical officers, flight sergeants and air mechanics of the Royal Air Force and the Royal Naval Air Service. It is not exactly speaking a text book on design, but is a good practical handbook on construction and care of airplane motors. There is scarcely a formula to be found in it, and the style is simplicity itself.

Beginning with the fundamental classification of various types of engines and a little thermodynamics, the book goes on to give very clearly the fundamental elementary points of cylinders, gudgeon pins and connecting-rods, camshafts, cams, etc. . . . Balancing is clearly explained. The chapters on drop-forgings and copper plating, etc., are extremely practical and valuable.

Mr. Sylvester may be complimented on having put into plain, practical form information so essentially necessary to everyone in the industry, which is yet so often cloaked in vagueness.

The Lakehurst Airship Shed

An airship of the same general type of the R-34, but larger, has been purchased by the U. S. Navy, and another of the largest type is to be built in this country.

To accommodate these airships and others to be built, the Navy is erecting at Lakehurst, N. J., a hangar of unprecedented size, for both assembly and housing purposes. Plans and specifications were prepared and contracts awarded by Sept. 8 for a building 804 ft. long, 318 ft. wide and 200 ft. high, with a frame of structural steel built on the three-hinged arch truss principle, each arch supported on steel towers 62 ft. high.

The entrance door is double, consisting of two leaves, each 177 ft. high and 136 ft. wide, framed in structural steel and braced to a thickness of 76 ft. at the bottom. Special railway track is provided as a runway for these immense portals. When fully opened, their upper contour forms an unbroken arch outline with the roof of the building, and the whole arrangement provides a windbreak nearly 600 ft. wide, insuring a large degree of safety in landing and releasing the ships. The magnitude of these doors can be better grasped when it is stated that a 12-story building with a frontage of 136 ft. could be placed within the hangar through the space covered by either leaf, with clearance to spare all around.

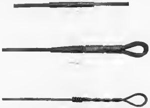
Overhead trolleys are provided for the construction of airships, and three docking rails of special design for landing, releasing and mooring purposes extend throughout the length of the building and for 1,500 ft. in front. The two standard-gauge railway tracks occupy similar spaces. The hangar is expected to be in service next summer.—From the Annual Report of the Secretary of the Navy.

Edstrom Machinery Company

WAR DEPARTMENT
BUREAU OF AIRCRAFT PRODUCTION
AIRPLANE ENGINEERING DEPARTMENT
McCook Field, Dayton, Ohio
U. S. A.

REPORT
Serial No. 646

on test of cable terminal connections made on the Edstrom Wire Wrapping Machine.



Finished Products of the Edstrom Machines

". . . It is to be noted that out of ten unsoldered specimens sizes 1/8" to 5/32", only one failed at a load below the rated capacity of the cable. The 3/16" specimens served with copper wire failed at loads averaging 71% of the full strength of the cable."

NOTE: The nine cables standing 100% were wrapped with the special strength wrapping wire we use on all our work.

". . . The Edstrom Wire Wrapping Machine . . . should be given a trial where such a machine is desired."

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Hall-Scott Type L6 Airplane Engines.

Lieut.-Colonel E. J. Hall, upon the orders of the Secretary of War, as shown in War Department General Orders No. 69, dated May 24th, 1919, was awarded the Distinguished Service Medal for exceptionally meritorious and conspicuous service rendered in the designing of the Liberty engine and subsequently in the adopting of the LeRhone engine to the American methods of production, and also in pushing to completion the American adaptation of the De-Haviland plane.

The mere fact that Lieut.-Colonel Hall is again associated with our company, taking an active interest in the design and production of Hall-Scott airplane engines, is a guarantee to our respective customers that they will receive a product entirely up to Hall-Scott standard, and second to none in the airplane market.

HALL-SCOTT MOTOR CAR COMPANY

West Berkeley, California

INDEX TO ADVERTISERS

Four Ignition Facts Regarding the Transcontinental Flight from New York to San Francisco and Return

Illustration showing approximately the route taken by the flyers in the transcontinental flight

1 Lieut. Belvin W. Maynard, winner of the race, drove a DH 4, the motors of which were equipped with Delco Ignition.

2 Lieut. Alex. Pearson, winner of second place, drove a DH 4, the motors of which were Delco-equipped.

3 Of the first 17 winners in the contest 16 were captured by planes equipped with Delco ignition.

4 Of the 74 planes originally entered in this contest 59 were equipped with Delco ignition.

And in the Trip Around the Rim of the United States

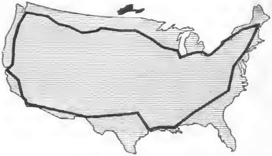

Illustration showing approximately the route taken by Col. Hartz in his trip around the rim of the United States

Col. R. S. Hartz, who drove a Martin Bomber equipped with Delco Ignition around the rim of the United States—a distance of 9,157 miles—said, "*During entire flight whenever it was hard to start the motors we found it was gasoline and not motor ignition that caused it.*"

The above furnishes additional evidance that De co Ignition is as supreme in the aviation field as Delco Starting, Lighting and Ignition is in the motor car industry.

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DAYTON OHIO, U. S. A.

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